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THE EFFECT OF GOOGLE WORKSPACE UTILIZATION ON THE EFFECTIVENESS OF DIGITAL COLLABORATION IN STUDENT GROUP PROJECTS

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ABSTRACT

The rapid move toward online systems in higher education has accelerated the use of cloud-based tools, with Google Workspace now a staple for student group projects. However, the high-end features of these technologies don't always guarantee effective teamwork, largely due to persistent socio-behavioral obstacles like social loafing. This research examined how the use of Google Workspace influences the performance of digital collaboration between students with a unique positioning of social loafing as a moderating factor. The research design used was quantitative, where data were gathered using the online survey (N=413 active university students in Indonesia who use Google Docs, Google Sheets, and Google Slides regularly). The data analysis was performed by the Partial Least Squares Structural Equation Modeling (PLS-SEM) through SmartPLS 4.0. Data findings show that the following variables make significant and positive contributions to the effectiveness of digital collaboration: Perceived Ease of Use (PEOU), Perceived Usefulness (PU), and Google Workspace Utilization (GWU). More importantly, the moderation analysis demonstrates a certain behavioral paradox: social loafing has a considerable negative impact on the advantages of perceived usefulness, yet it does not moderate the actual use of technology behavior. This suggests that passive students might often use the platform, but they fail to contribute anything of substantive value, thus worsening the team dynamics. The study adds to the body of knowledge in the Technology Acceptance Model (TAM) by demonstrating that the process of adopting technologies in collaborative settings should be accompanied by proactive pedagogic interventions that would help prevent the issue of free-riding.
Keywords: *Google Workspace, Digital Collaboration, TAM, Social Loafing, PLS-SEM*

1. INTRODUCTION

The transformation of higher education by digital technology has changed the way students interact and collaborate on academic projects. Platforms such as Google Workspace, which includes Google Docs, Google Sheets, and Google Slides, provide collaborative features such as live comments, real-time editing, and change history to monitor team members' work. A report released by Google for Education (2021) states that more than 170 million students and educators worldwide use Google Workspace to facilitate online education [1] . In Indonesia, Google Workspace has been integrated in several universities, including Satya Wacana Christian University (UKSW) and Dian Nusantara University (UNDIRA) [2], [3] . This shows that the use of digital collaborative platforms has become part of the higher education transformation process in Indonesia.

However, more frequent use of collaborative technology does not guarantee the effectiveness of student group work. In practice, phenomena such as social loafing often arise, which is the tendency of certain group members to reduce their contribution to the online work process. Research shows that social loafing among Indonesian students is related to a low achievement orientation [4] . There is concern about complaints from students regarding group members who are inactive in online assignments [5] . In fact, Google Workspace features such as activity trackers and history allow for the monitoring of individual member contributions. However, these features have not been optimally utilized by students and educational institutions [6], [7] .

This condition shows a mismatch between what technology can do and what student social behavior can do in digital collaboration.

The application of the Technology Acceptance Model (TAM) theory has been used in previous studies to describe the adoption of learning technology among students. The perception of the ease of use and usefulness of Google Workspace has a positive impact on collaboration among students [8].

While the Technology Acceptance Model (TAM) has been extensively validated in explaining students' adoption of educational technologies [9], most prior studies primarily examine individual perceptions of usefulness and ease of use as direct predictors of behavioral intention or system usage [10], [11]. There is little evidence that has brought together the socio-behavioral moderators in a systematic manner to understand how technology acceptance leads to actual collaborative performance outcomes in digital team settings. Specifically, the question of interaction between the utilization of technological devices and the process of social loafing is under-researched in the setting of higher educational organizations [12].Thus, this paper fills this gap by combining TAM with the socio-behavioral concept of Social Loafing to investigate the interdependence of technological acceptance and behavioral processes in defining the overall effectiveness of digital collaboration among university students. This research is valuable to the literature on digital collaboration effectiveness in higher education in that it combines technological acceptance and socio-behavioral dynamics into a single structural model.

The aim of the present study is to evaluate the effect of Google Workspace utilization on the effectiveness of digital collaboration among students. The originality of this research lies in the integration of a socio-behavioral moderator—social loafing—into the traditional Technology Acceptance Model (TAM) [9] to assess actual collaborative performance rather than mere adoption intentions.

To narrow down the topic, the study will be limited to active university students in Indonesia who use Google Workspace (Docs, Sheets, and Slides) to complete academic group work. It evaluates Perceived Ease of Use, Perceived Usefulness, and platform use and its direct influence on the effectiveness of digital collaboration. Other collaboration tools (e.g., Microsoft Teams, Notion) or asynchronous individual tasks are not discussed in this study. It is supposed that the respondents are all sufficiently digitally literate to use cloud-based tools. The main limitation of this study, though, is that social loafing is operationalised as a general perception of behaviour by use of self-reported surveys, and hence it may not reflect particular psychological subtypes of loafing (retributive or strategic loafing).

The rest of this paper is organized as follows: Section 2 reviews the theoretical background, including digital transformation, TAM, and social loafing, leading to the development of the hypotheses. Section 3 outlines the research methodology, involving the research model, sampling, and data collection procedures. Section 4 provides the descriptive statistics, the outputs of the structural equation modeling, and an in-depth discussion of the empirical findings. Lastly, Section 5 concludes the study, mentioning the limitations and suggesting future research directions.

2. THEORETICAL BACKGROUND

2.1 Digital Transformation in Higher Education

Higher education is changing the way students interact and collaborate using cloud computing technology [1]. Google Workspace (which includes Google Docs, Sheets, and Slides) enables real-time collaboration and comes with features such as comments, real-time editing, and version history that enhance transparency [1], [6]. Google Workspace has been introduced at universities in Indonesia, including UKSW and UNDIRA, as part of their learning digitization strategy [2], [3] . Perceived usefulness and perceived ease of use determine the success of this technology's adoption [13] .

2.2 Digital Collaboration and Collaboration Effectiveness

Digital collaboration refers to technology-based collaboration to achieve common goals [14] . The success of a group is determined by its ability to communicate, share responsibilities, and coordinate[15] . Collaboration heavily relies on the clarity of contributions made by members [16] . Comment features and revision history in Google Workspace help ensure transparency and accountability[8] . However, research indicates that insufficient digital literacy poses a barrier to the optimal utilization of these features. [14], [17] .

2.3 Technology Acceptance Model (TAM)

The TAM model explains that technology acceptance depends on Perceived Ease of Use (PEOU) and Perceived Usefulness (PU)[13]. PEOU describes users' beliefs about ease of use, while PU indicates the opinion that technology can improve

performance [17] . One study shows that PEU and PU positively influence student engagement and the success of collaboration with the help of Google Workspace [10], [11]. Therefore, TAM provides a theoretical basis for explaining student behavior in the use of digital learning technology.

2.4 The Phenomenon of Social Loafing in Student Collaboration

Social loafing is the tendency of individuals to reduce their efforts when working in a team compared to when working alone [12] . This is common in online collaboration due to the lack of supervision [18] . It has been found that a lack of motivation and responsibility can exacerbate social loafing, which has a negative impact on group effectiveness [4], [19] . Research in Indonesia found that the level of social loafing among students ranged from moderate to high, although this could be reduced to the lowest level with the help of transparency of contributions and a clear division of tasks [20], [21].

2.5 Likert Scale Measurement

The Likert scale is used in social and educational research to determine respondents' attitudes, perceptions, and opinions toward a phenomenon. This theory was introduced and developed as a graded response-based measurement method to explain the degree to which people agree with a statement [22]. This scale generally has 4 to 7 response categories, such as strongly disagree, disagree, neutral, agree, and strongly agree.

The Likert scale is an ordinal scale that is generally considered interval data, so that it can be analyzed using parametric statistics [23] . The main advantage of this scale is its ability to quantitatively express changes in respondents' attitudes and its ease of use in both online and offline surveys. According to this study, the Likert scale was applied to perceived ease of use (PEOU), perceived usefulness (PU), digital collaboration effectiveness, and levels of social loafing among students.

2.6 Virtual Team Dynamics and Social Loafing

Collaboration in a virtual environment presents unique challenges that differ from traditional face-to-face settings, primarily due to the lack of direct physical supervision [18], [24]. In digital workspaces, social loafing becomes a prevalent threat because members may feel less individual responsibility compared to working alone [12], [19]. Unlike physical classrooms, digital platforms rely on features such as comment sections and revision history to ensure transparency and accountability [8]. However, research in Indonesia found that the level of social loafing among students remains a concern, often ranging from moderate to high levels [20], [21]. Recent studies suggest that the "transparency features" of cloud platforms are critical interventions to mitigate these dynamics, yet their effectiveness is still heavily moderated by the individual's motivation and the team's internal cohesion [25].

2.7 Hypothesis Development

2.7.1 The effect of perceived ease of use on perceived usefulness

Perceived Ease of Use (PEOU) refers to the extent to which students believe that using Google Workspace is effortless [13]. The original Technology Acceptance Model (TAM) states that intuitive and user-friendly systems substantially decrease the cognitive load of users, which leads to an increase in the perceived functional value. When a digital resource is usable, students will be able to pay more attention to accomplishing their tasks instead of struggling with technical difficulties.

Features such as real-time editing and version history are more likely to be perceived as useful when they are convenient to use. With the reduction of technical barriers, students become increasingly aware that the platform is enhancing their productivity and coordination effectiveness [11]. Thus, in keeping with TAM theory, the perceived ease of use should have a positive impact on the perceived usefulness of Google Workspace in student group projects.

H1: Perceived Ease of Use (PEOU) has a positive effect on Perceived Usefulness (PU).

2.7.2 The effect of perceived usefulness on digital collaboration effectiveness

The ability of the group members to communicate, share responsibilities, and coordinate determines the success of digital group work [10]. Perceived Usefulness (PU) is the subjective view of the extent to which using Google Workspace will enhance the performance and effectiveness of the group in conducting activities [17]. Whenever students believe that the features of Google Workspace, such as real-time editing and revision history, are truly going to contribute to effectiveness and transparency in conducting activities, they will experience higher satisfaction with their participation and collaboration [8], [17].

H2: Perceived Usefulness (PU) has a positive effect on Digital Collaboration Effectiveness (DCE).

2.7.3 The effect of perceived ease of use on digital collaboration effectiveness

In addition to its indirect influence on Perceived Usefulness, PEOU has a direct influence on the way users interact with educational technology [11]. The barrier to entry for any member of the group is reduced by a high degree of flexibility and ease of learning within Google Workspace. A conducive environment is more easily attained when a platform is user-friendly, and students do not feel frustrated, which helps facilitate more active participation and higher quality of work output [8].

H3: Perceived Ease of Use (PEOU) has a positive effect on Digital Collaboration Effectiveness (DCE).

2.7.4 The effect of Google Workspace utilization on digital collaboration effectiveness

Digital collaboration can be defined as teamwork with the help of technology in order to reach shared objectives [14]. Google Workspace Utilization (GWU) is an indicator of the frequency of use, the intensity of use, and feature dependency among learners [15]. The more the students use collaborative functions—such as leaving comments and editing documents together in real-time the more organized their cooperation becomes. Intensive use of the platform turns it into a workspace rather than a storage instrument, and, consequently, makes it more effective [14], [15].

H4: Google Workspace Utilization (GWU) has a positive effect on Digital Collaboration Effectiveness (DCE).

2.7.5 The moderating role of social loafing on perceived usefulness

Although collaborative technology is highly functional, group dynamics are still important. Social loafing is the phenomenon of individuals limiting their efforts whenever they are working in a group rather than when they are working individually [12]. A lack of supervision and low achievement orientation are known to exacerbate this phenomenon in digital environments [4]. Another study shows that the impression of free-riders in online teams may harm trust and unity [26]. By extension, although students may strongly believe in the usefulness of Google Workspace (PU), the existence of low-effort and non-contributing members will negatively impact the effectiveness of the entire group [19].

H5: Social Loafing (SL) moderates the effect of Perceived Usefulness on Digital Collaboration Effectiveness (DCE).

2.7.6 The moderating role of social loafing on utilization

The technical action of using a platform does not necessarily remove behavioral problems. Even though a student may be a constant user of Google Docs (high GWU), when their personal input is minimal, and they are very dependent on their classmates, then the collaboration will not be optimal [20]. Social loafing is a behavioral deterrent that may undermine the desirable results of high technology use, and therefore, more research needs to be done on its moderating role.

H6: Social Loafing (SL) moderates the effect of Google Workspace Utilization on Digital Collaboration Effectiveness (DCE).

2.8 Problem Statement and Research Questions

The socio-technical gap between the advanced features of Google Workspace and the real-life collaborative behavior of students is the root issue of this study [27]. Although cloud-based platforms offer more transparency than ever before, educational institutions still encounter problems where this transparency is not fully exploited [6], [7]. Past experiences show that a higher frequency of using collaborative technology does not necessarily ensure better group outcomes. This inconsistency results in a paradox where high technology use may not always lead to team synergy, mostly because the unchecked impact of social loafing causes some members to lessen their input during the online process [4]. Thus, there is an urgent need to empirically examine how these behavioral barriers interact with technology acceptance to determine the ultimate success of digital collaboration in the post-digital era [13].

Based on the literature critique and the problem statement above, this study aims to answer the following research questions:

1. How do technology acceptance (Perceived Ease of Use and Perceived Usefulness) and Google Workspace Utilization influence the effectiveness of digital collaboration among students?
2. How does social loafing moderate the relationship between technology utilization, perceived usefulness, and digital collaboration effectiveness?

3. RESEARCH METHODOLOGY

3.1 Research Model

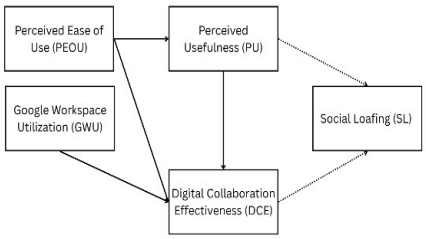

Figure 1: Research Model

This study used a survey method with six main variables and a quantitative methodology. Figure 1 illustrates the variables used in this study, namely Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Google Workspace Utilization (GWU), Digital Collaboration Effectiveness (DCE), and Social Loafing (SL) as a moderator variable. The hypotheses to be tested using these variables are:

H1: Perceived Ease of Use (PEOU) has a positive effect on Perceived Usefulness (PU)[9] .
H2: Perceived Usefulness (PU) has a positive effect on Digital Collaboration Effectiveness (DCE)[8], [14] .
H3: Perceived Ease of Use (PEOU) has a positive effect on Digital Collaboration Effectiveness (DCE)[10], [11] .
H4: Google Workspace Utilization (GWU) has a positive effect on Digital Collaboration Effectiveness (DCE)[15] .
H5: Social Loafing (SL) moderates the effect of Perceived Usefulness on Digital Collaboration Effectiveness (DCE)[12], [19].
H6: Social Loafing (SL) moderates the effect of Google Workspace Utilization on Digital Collaboration Effectiveness (DCE)[20] .

3.2 Research Type and Approach

The research design used is a quantitative research design and a Likert scale questionnaire survey. This aims to empirically test the influence of these variables through the use of numbers [28]. This research design is causal and will be applied to test the influence of using Google applications in the workplace on digital collaboration among students, with the phenomenon of social loafing as a moderating factor.

3.3 Research Paradigm

The paradigm used is the positivistic paradigm, which focuses on objective observation of social reality with the help of quantitative data [29] . This paradigm is relevant because this study will attempt to empirically test the Technology Acceptance Model (TAM), Social Loafing Theory, and Collaboration Effectiveness Theory with the help of statistical tools.

3.4 Research Location and Time

- Location: Online
- Period: December 16, 2025 – January 31, 2026
- Media: Google Form Questionnaire
- Context: Students who have used Google Docs, Sheets, and Slides in group projects.

3.5 Research Population and Sample

- Population: Active students in Indonesia, totaling 7,246,906 people based on PDDikti data[30] .
- Sampling Method: Purposive Sampling, which is the selection of respondents based on specific criteria.
- Respondent Criteria:
  - Active students at universities in Indonesia.
  - Have used Google Workspace (Docs, Sheets, Slides)

The sample size was determined using the Slovin formula [31] with a margin of error of 5% (e = 0.05) and a population of 7,246,906 active students[30] :

$$n = \frac{N}{1 + N(e^2)} n = \frac{7.246.906}{1 + 7.246.906(0{,}05^2)}$$

$$n = 399{,}98 \approx 400$$

The sample size of 399.98 was rounded up to 400 respondents, which is sufficient for PLS-SEM analysis, considering statistical power and model complexity [3] , and not solely relying on the "10-times rule" [26], [32] .

3.6 Research Instruments

The instrument used was a closed-ended questionnaire
with a 5-point Likert scale:
1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

3.7 Variable Measurement

Table 1: Research Variable

Variable	Code	Indicator	References
Perceived Ease of Use (PEOU)	PEOU 1	Ease of Navigation	(Davis, 1989; Emilzoli et al., 2025)
	PEOU 2	Ease of Learning	
	PEOU 3	Flexibility of Use	
Perceived Usefulness (PU)	PU1	Increased Productivity	(Davis, 1989; Emilzoli et al., 2025)
	PU2	Communication Effectiveness	
	PU3	Coordination Effectiveness	
Google Workspace Utilization (GWU)	GWU1	Frequency of Use	(Nokhil et al., 2024)
	GWU2	Usage Intensity	
	GWU3	Feature Dependency	
Digital Collaboration Effectiveness (DCE)	DCE1	Active Participation	(Scager et al., 2016; Nokhil et al., 2024)
	DCE2	Quality of work output	
	DCE3	Collaboration satisfaction	
Social Loafing (SL)	SL1	Lack of Contribution	(Karau & Williams, 1993; Oktari, 2021)
	SL2	Dependence on Friends	
	SL3	Low Effort	

Table I presents comprehensive details regarding the research variable indicators, complete with codes and supporting references, which form the basis for measurement and analysis of the constructs in this study.

3.8 Data Analysis Method Instrument

The analysis was conducted using Partial Least Squares – Structural Equation Modeling (PLS-SEM) with SmartPLS 4.0 software.

Validity and Reliability Tests (External Model): tested convergent and discriminant validity.

- Validity and Reliability Tests (External Model): Measuring convergent and discriminant validity for the variables PEOU, PU, GWU, DCE, and SL
- Structural Model Testing (Internal Model): Testing the relationship between latent variables.
- Hypothesis Testing: Based on path coefficient values and significance (p-value).
- Moderation Analysis: Determining the impact of social loafing on the relationship between X and Y.

4. RESULTS AND DISCUSSION

4.1 Respondent Demographics

A total of 413 respondents participated in this study. All respondents were known to be active students who had used Google Workspace services. Thus, 413 respondents were included in the analysis. Table II presents the demographic profile of the 413 respondents. The majority were female (50.4%), and most were aged between 21 and 23 years (61.5%). Based on educational level, the majority were pursuing a Bachelor's degree (80.1%) and came from private universities (69.5%). In addition, most respondents were currently in their 7th semester or above (38.5%) or in their 5th–6th semester (34.4%).

Table 2: Respondent Demographics

Criteria	Description	Total	Percentage
Gender	Male	205	49.6%
	Female	208	50.4%
Age	< 18 Years Old	20	4.8%
	18–20 Years Old	60	14.5%
	21–23 Years Old	254	61.5%
	24–26 Years Old	71	17.2%
	>26 Years Old	8	1.9%
Type of University	Public University (PTN)	119	28.8%
	Private University (PTS)	287	69.5%
	Higher Education School	7	1.7%
Education Level	Diploma (D3/D4)	60	14.5%
	Bachelor's Degree (S1)	331	80.1%
	Postgraduate (S2/S3)	22	5.3%
Current Semester	Semester 1–2	44	10.7%
	Semester 3–4	68	16.5%
	Semester 5–6	142	34.4%
	Semester 7 and above	159	38.5%

4.2 Descriptive Statistics

Before testing the structural model, descriptive statistics were evaluated to understand the general tendency of the respondents' perceptions regarding the variables under study. The measurements were based on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 3: Validity Convergence Tests

Variable	Mean	Standard Deviation	Category
PEOU	4.00	1.05	High
PU	4.00	1.04	High
GWU	3.74	1.10	High
DCE	3.64	1.12	High
SL	2.75	1.49	Moderate

According to the descriptive analysis, the mean scores of both Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) are the highest (4.00), which means that students have a very positive attitude towards the interface of the technology and its utility. Moreover, Google Workspace Utilization (GWU) and Digital Collaboration Effectiveness (DCE) are also rated as high values (mean >3.40), which means that students do use the features of the platform and tend to have a positive overall level of collaboration effectiveness. Surprisingly, the Social Loafing (SL) variable has an average value (2.75) with the greatest standard deviation (1.49). This implies that passive behavior is not necessarily the absolute dominant norm in all groups, but this does exist and differs significantly among different student groups, thus necessitating the need to examine its moderating effect in this study.

4.3 Model Fit

Model Fit evaluation was conducted to verify the suitability of the theoretical model with empirical data prior to hypothesis testing. The main indicators used were Standardized Root Mean Square Residual (SRMR) and Normed Fit Index (NFI).

Based on Table 4, the model produced an SRMR value of 0.046. This value is below the threshold of 0.08, indicating a good fit between the observed and predicted correlations. In addition, the NFI value was recorded at 0.909, exceeding the recommended standard (> 0.90), indicating a strong model fit. With both criteria met, the structural model was declared valid and suitable for proceeding to the next stage of analysis.

Table 4: Model Fit

Criteria	Saturated Model	Estimated Model
SRMR	0.033	0.046
d_ULS	0.128	0.249
d_G	0.212	0.223
Chi-square	525.494	540.345
NFI	0.911	0.909

4.4 Measurement Model

In this study, data were analyzed using SMART-PLS 4 software. After the processed data were collected, the results included validity and reliability testing. The following is an evaluation of the results of both tests.

Table 5: Validity Convergence Tests

Code	Outer Loading	Status
PEOU1	0.905	Valid
PEOU2	0.924	Valid
PEOU3	0.901	Valid
PU1	0.901	Valid
PU2	0.914	Valid
PU3	0.918	Valid
GWU1	0.913	Valid
GWU2	0.927	Valid
GWU3	0.919	Valid
DCE1	0.916	Valid
DCE2	0.913	Valid
DCE3	0.914	Valid
SL1	0.961	Valid
SL2	0.963	Valid
SL3	0.956	Valid

Convergent validity testing was conducted using factor loading values to ensure that each indicator accurately represented the variable construct being studied. To analyze the reflective model, it is recommended to use an outer loading greater than 0.70. Indicators with loading values below the threshold were eliminated in accordance with this theory to improve the precision of the measurement model.

In this study, no indicators were removed because all indicators showed excellent performance. Table 5 shows the results of the convergent validity test, which indicates that each indicator is reliable for assessing the relevant variable and has an outer loading value greater than 0.70[33].

Table 6: Reliability Test Results

Code	Cronbach's Alpha	Composite Reliability	AVE
PEOU	0.896	0.897	0.828
PU	0.898	0.898	0.830
GWU	0.909	0.909	0.846
DCE	0.902	0.902	0.836
SL	0.958	0.959	0.922

Reliability tests were also conducted in this study to evaluate the effectiveness of the research instruments. In this study, each variable showed a Cronbach's Alpha value exceeding 0.70, indicating substantial reliability [33]. Table 6 also shows that all variables or factors in this study have high consistency in measuring each indicator, with a Composite Reliability value exceeding 0.70[33] . In addition, the Average Variance Extracted (AVE) value must be at least 0.50[24] . In this study, all variables have an AVE value above 0.80. Together, these metrics provide an evaluation of internal consistency and construct dependency, ensuring the validity of the study results.

4.5 Discriminant Validity

In addition to convergent validity, discriminant validity was evaluated to ensure that each latent construct is truly distinct from the others empirically. Following the modern guidelines for PLS-SEM [33], The Heterotrait-Monotrait (HTMT) ratio of correlations was utilized.

As presented in Table 7, the majority of the HTMT values between the research variables are well below the conservative threshold of 0.85. There is one relationship, namely between Perceived Ease of Use (PEOU) and Perceived Usefulness (PU), which yielded an HTMT value of 0.932, slightly exceeding the 0.90 threshold.

However, this value can be theoretically justified within the original Technology Acceptance Model (TAM) framework, where Perceived Ease of Use is explicitly positioned as a direct antecedent of Perceived Usefulness. Since this is a structural dependency, it is theoretically expected that there is a strong empirical relationship between these constructs, but not a sign of construct redundancy. Hence, although the difference between the HTMT value is quite high, the discriminant validity is deemed acceptable within the theoretical framework of TAM-based models. Moreover, every construct has a high Average Variance Extracted (AVE > 0.80), which supports high convergent validity and is another argument in favor of the fact that the measurement model is adequate.

Table 7: Discriminant Validity (HTMT Ratio)

	DCE	GWU	PEOU	PU	SL
DCE					
GWU	0.627				
PEOU	0.858	0.663			
PU	0.876	0.694	0.932		
SL	0.434	0.060	0.043	0.040	

4.6 Collinearity Assessment (VIF)

Prior to evaluating the structural relationships and effect sizes, it is mandatory to examine the model for potential multicollinearity issues among the predictor constructs. Following the guidelines [33], The Variance Inflation Factor (VIF) was utilized, with a conservative threshold value of strictly below 5.0.

Table 8: Inner Model Collinearity Statistics (VIF)

Predictor Construct	Target Construct: PU	Target Construct: DCE
PEOU	1.000	3.447
PU		3.646
GWU		1.720
SL		1.004
SL x PU		1.772
SL x GWU		1.764

Table 8 results indicate that all inner VIF values are between 1.000 and 3.646, which is well below the conservative threshold of 5.0. These values demonstrate that multicollinearity is not a concern in the structural model. As such, the substantial effect size ($f^2 = 2.327$) between Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) is not likely due to statistical redundancy or overlapping constructs. Rather, it is an expression of the theoretical structural dependence between these constructs, as originally visualized in the Technology Acceptance Model (TAM), with PEOU being a direct antecedent of PU.

4.7 Structural Model

The structural model evaluation aims to test the causal hypotheses between the hypothesized latent variables. This analysis includes analyzing the coefficient of determination (R-square) to determine the predictive ability of the model, as well as the path coefficients for relationship significance. R-square values are classified into three categories: ≥ 0.75 (strong), 0.50–0.75 (moderate), and ≤ 0.25 (weak) [33]. As indicated in Table 9, Digital Collaboration

Effectiveness (DCE) is the main dependent variable with an R-square of 0.814. This value is in the strong category, which means that the model is a strong predictor. In particular, it implies that the joint effect of Perceived Ease of Use, Perceived Usefulness, Google Workspace Utilization, and the moderating role of Social Loafing can explain 81.4 percent of the variance in the effectiveness of digital collaboration in students. The remaining 18.6 percent is also affected by other external variables that are not studied in this research, such as intrinsic motivation, quality of internet infrastructure, or certain leadership styles among the groups of students.

Meanwhile, the Perceived Usefulness (PU) construct obtained an R-square value of 0.699. This indicates a moderate to strong predictive accuracy, meaning that approximately 69.9% of the variation in how useful students perceive Google Workspace to be is determined by its Perceived Ease of Use. This substantial value reaffirms the fundamental TAM assumption that minimizing the technical complexity of an application is the most effective way to enhance its perceived functional utility in an educational setting.

Table 9: R-Square Table

Dependent Variable	R-Square	**Category**
Digital Collaboration Effectiveness (DCE)	0.814	Strong
Perceived Usefulness (PU)	0.699	Moderate

Table 10: Path Coefficient Value

Hyp	**Path**	β	**t**	**p**	**Result**
H1	*PEOU -> PU*	0.836	57.748	< 0.05	*Accepted*
H2	*PU -> DCE*	0.454	11.097	< 0.05	*Accepted*
H3	*PEOU -> DCE*	0.334	8.699	< 0.05	*Accepted*
H4	*GWU-> DCE*	0.071	2.449	0.014	*Accepted*
H5	*SL x PU -> DCE*	-0.096	3.22	0.001	*Accepted*
H6	*SL x GWU -> DCE*	-0.004	0.126	0.900	*Not Accepted*

Table 10 presents the types of relationships and levels of significance between variables. Since all T-statistic values (except H6) exceed the threshold of 1.96 and all P-values are below 0.05, each relationship can be considered statistically significant [33].

However, there is one relationship (H6) that does not meet the threshold and is considered insignificant. Conversely, most of the other relationships meet the threshold and are considered significant.

4.8 Effect Size (f^2)

While path coefficients and p-values indicate the significance of a relationship, they do not assess the magnitude of the effect. Therefore, the effect size f^2 was evaluated. According to Hair et al. [33], f^2 values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively.

Table 11: Effect Size (f^2)

Relationship	**f^2 Value**	**Effect Size Category**
PEOU -> PU	2.327	Large
PU -> DCE	0.304	Medium to Large
PEOU -> DCE	0.174	Medium
GWU -> DCE	0.016	Small
SL x PU -> DCE	0.029	Small
SL x GWU -> DCE	0.000	No Effect

According to Table 11, Perceived Ease of Use (PEOU) exhibits a high effect size on Perceived Usefulness (f^2 = 2.327). This value is larger than the traditional standard for a large effect (0.35), but it is theoretically aligned with the Technology Acceptance Model (TAM), where PEOU is the main antecedent of PU. Since PU can be to a large degree explained by PEOU (R^2 = 0.699), this magnitude reflects structural dependency rather than statistical distortion. Furthermore, the strength of the influence of Perceived Usefulness on Collaboration Effectiveness is also medium to large (0.304). On the other hand, while GWU is statistically significant, its practical effect size (f^2 = 0.016) is relatively small. Regarding moderation, it can be seen that the interaction of Social Loafing on the PU-DCE relationship has a small but meaningful moderation effect (f^2 = 0.029), but it has no observable effect size (f^2 = 0.000) on the GWU-DCE relationship, which is taken as the rejection of Hypothesis 6.

4.9 Predictive Relevance (Q^2)

Besides assessing the size of the R-square values, current PLS-SEM best practice guidelines suggest that out-of-sample predictive power of the model should be evaluated by means of the PLSpredict procedure [33]. The PLSpredict algorithm produces Q^2 predict values, which are measures of how well the path model can predict originally observed values of new cases. A Q^2 value greater than zero for a particular reflective endogenous construct means that the path model has predictive relevance.

Based on the PLSpredict analysis, the Q^2 predict value for the Perceived Usefulness (PU) construct is 0.697, and the main dependent variable, Digital Collaboration Effectiveness (DCE), has a Q^2 of 0.745. Both values are significantly above zero, meaning that the integrated theoretical model has high predictive relevance. These results provide an indication that technology acceptance and the use of Google Workspace for digital collaboration, as well as the moderating effect of social loafing, have significant predictive value in determining digital collaboration effectiveness among students.

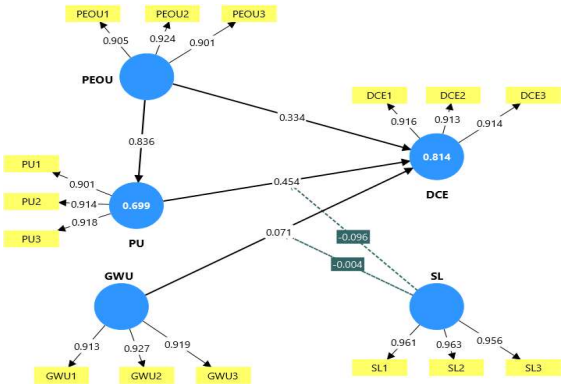

Figure 2: PLS Algorithm Result

Figure 2 presents the structural model generated using the SmartPLS algorithm. This diagram visually depicts the relationships between the latent variables and the outer loading values of each indicator, which are considered as visual aids in the assessment of measurement validity and structural relationships within the model.

4.10 Discussion

4.10.1 The Role of Technology Acceptance In Digital Collaboration

The empirical findings of this paper strongly support the underlying assumptions of the Technology Acceptance Model (TAM) in the setting of higher education. The structural model analysis indicates that Perceived Ease of Use (PEOU) is a key antecedent, which has significant effects on Perceived Usefulness ($p < 0.05$) and Digital Collaboration Effectiveness ($p < 0.05$). This shows that as Google Workspace applications like Docs, Sheets, and Slides are perceived as user-friendly and, at the same time, responsive, students experience a lower cognitive load. They do not need to struggle with technical navigation, and instead, can focus straight on academic brainstorming and content creation. This smooth interaction directly enhances the perceived functional value of the technology [8].

This significant empirical impact ($f^2 = 2.327$) is further evidence of the central place of the perceived ease of use in the TAM model, where the simplicity of the interface has a leading influence on the formation of perceived utility.

Besides, there is a significant positive influence of Perceived Usefulness (PU) on Digital Collaboration Effectiveness. This is in line with the argument that perceived usefulness increases technology adoption success. Having a real-life belief that collaborative features (real-time editing, version history, and integrated comment section) simplify their communication and coordination of a project, students have more chances to become active and create high-quality collaborative output [13].

4.10.2 The Impact of Google Workspace Utilization

Beyond mere perception, the actual usage of the platform is essential. This research discovered that Google Workspace Utilization (GWU) has a significant and positive impact on collaboration effectiveness ($p = 0.014$). This observation means that the intensity, frequency, and dependency on these digital tools transform a stagnant digital space into a dynamic working space. Ongoing usage also guarantees that all team members are kept aligned, thereby reducing information asymmetry and misunderstandings when handling group projects [10]. The more the students take advantage of the collaborative capabilities of the platform, the more their workflow is made visible.

4.10.3 The Moderating Paradox of Social Loafing

The most intriguing contribution of this research lies in the moderating role of Social Loafing (SL). The analysis presents a paradoxical dynamic: SL significantly and negatively moderates the relationship between PU and DCE (H5 accepted, $p = 0.001$), yet it fails to moderate the relationship between GWU and DCE (H6 rejected, $p = 0.900$).

The acceptance of H5 underscores a critical behavioral reality: sophisticated technology cannot fully compensate for a lack of individual responsibility[15]. Even if an active student highly perceives Google Workspace as a powerfully useful tool, the visible presence of "free-riders" within the digital workspace damages team morale. In online settings, seeing group members who are inactive or contribute minimally causes a sense of inequity among the active members. This psychological demotivation erodes the potential benefits that the technology offers, ultimately degrading the overall effectiveness of the collaboration[17].

Conversely, the rejection of H6 provides important insight into how social loafing manifests digitally. The finding reveals that the frequency of tool usage (GWU) is independent of loafing behavior. In a digital context, a passive student might frequently open a shared Google Docs, generating high "utilization" metrics (e.g., showing up as an active viewer), but still fail to contribute substantively to the project[18]. This phenomenon can be termed as "active on the keyboard, absent in contribution." It highlights that social loafing is a fundamental socio-psychological issue that cannot be mitigated simply by forcing students to log into an application more frequently. Technical activity does not equate to collaborative productivity.

4.10.4 Theoretical and Practical Implications

Theoretically, this study is an extension of the TAM paradigm in the sense that a socio-behavioral variable (Social Loafing) is introduced as a moderator. It confirms that technology acceptance models in teamwork should consider group dynamics because personal attitudes towards technology are extremely sensitive to collective behaviors. This integrated model has a high predictive relevance ($Q^2 > 0.69$), which gives high empirical confidence to these claims.

In practice, the results in the form of recommendations that can be applied to a range of stakeholders in the higher education ecosystem include:

- For University Educators: Lecturers are motivated to consider Google Workspace capabilities such as "Version History" and "Activity Dashboard" as active grading tools as opposed to passive logs in order to determine individual responsibility.
- For Academic Institutions: Universities should not stop at digital transformation strategies that only offer infrastructures, but instead adopt active pedagogical structures that reduce social loafing.
- For Virtual Teams: The adoption of obligatory peer-evaluation rubrics and electronic submissions may serve as a psychological deterrent to the tendencies of free-riding, thus improving the general quality of collaborative work output.

4.10.5 Critical Analysis of Findings (PMIs)

To objectively analyze the results and compare them to related literature, this paper utilizes the PMI (Plus, Minus, Interesting Facts) model to demonstrate the strengths, weaknesses, and novel findings of this study:

- Plus (Strengths and Positive Confirmations): In line with previous studies conducted by Ayanwale et al. [10] and Nokhil et al. [15], this study validates the strong positive influence of Perceived Ease of Use and Perceived Usefulness on collaboration effectiveness. The primary advantage of this research is that it empirically validates that actual Google Workspace usage facilitates a positive transition from a static digital environment into a productive workspace. This work stands out by successfully relating platform usage directly to collaborative output, unlike many prior studies that focused primarily on adoption intention [11].
- **Minus (Weaknesses and Behavioral Limitations):** A major limitation identified in the digital collaboration environment is that technological sophistication alone cannot overcome socio-psychological realities. Although prior literature suggests that cloud platforms enhance accountability [8], the findings reveal the persistent presence of social loafing. This is consistent with Aggarwal and O'Brien [34], who argue that sociotechnical environments may increase free-riding if individual contributions are not adequately monitored or rewarded. The presence of free-riders undermines the perceived usefulness of the platform, thereby reducing overall team morale and performance [17], [19].
- **Interesting Facts (The Digital Loafing Paradox):** The most notable finding emerged from the moderation analysis of platform usage. Contrary to traditional offline assumptions that lack of

contribution implies physical absence, this study reveals a digital paradox: "active on the keyboard, absent in contribution." Less active participants may frequently access the platform (resulting in high utilization metrics) without making meaningful contributions to academic tasks. According to Abraham [35], technological characteristics do not necessarily reduce social loafing in virtual teams. This finding highlights that technical activity data is not equivalent to collaborative productivity.

5. CONCLUSION

The main objective of the study was to examine the effects of using Google Workspace on the effectiveness of online group work among students. This study is innovative and makes a significant contribution to the literature, as it is one of the few studies that integrates the socio-behavioral concept of Social Loafing with the Technology Acceptance Model (TAM). The empirical data demonstrate that the effectiveness of digital collaboration is not merely the result of technological availability, but a multifaceted interaction driven by Perceived Ease of Use (PEOU), Perceived Usefulness (PU), and Google Workspace Utilization (GWU).

The implications of these findings in the modern post-pandemic digital education environment indicate that technological provision without behavioral management leads to suboptimal learning outcomes. A key finding of this study is the moderating role of social loafing: although it significantly reduces the effect of perceived usefulness, it does not moderate actual platform usage. This reflects a digital paradox, where a high frequency of student logins does not guarantee substantial academic contribution.

To address the issue of free-riding identified in this study, several practical solutions for educational institutions are proposed. Faculty members should shift from passive observation to active pedagogical interventions. The final solution involves the enforced integration of automated activity logs (e.g., Google Workspace Version History) combined with structured 360-degree peer-assessment rubrics. The implementation of these tools as rigorous evaluation mechanisms will serve as a psychological deterrent, ensuring individual accountability and mitigating the negative effects of social loafing in virtual teams.

5.1 Limitations and Future Research Directions

Although this study provides valuable insights, there are several limitations that could be the subject of future research. First, the Social Loafing variable was measured as a broad behavioral perception without dividing it into specific types of psychological orientations, including retributive loafing (reducing effort because others are also doing so) and strategic loafing (reducing effort because competent coworkers will cover up shortcomings). Second, this study is based on survey data self-reported by respondents, making it susceptible to respondent bias.

From these limitations, future research should delve into the multifaceted dimensions of social loafing in much greater detail. Subsequent studies are encouraged to incorporate a broader range of variables, such as group cohesion, digital literacy, or transformational leadership, to better understand their moderating roles within student groups. Furthermore, employing a mixed-methods approach that combines quantitative surveys with qualitative interviews or the direct observation of Google Workspace activity logs could yield a more holistic understanding of digital collaboration dynamics.

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Open data can be accessed at https://zenodo.org/records/18706553

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